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SCIENTIFIC TRANSLATION SERVICES
411 Wyntre Lea Dr.
Bryn Mawr, PA 19010

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(71) Applicant:
Siemens AG, 8000 Munich, DE

(72) Inventor:
Matschi, Helmut, Cert. Eng. (FH), 8408 Barbing, DE

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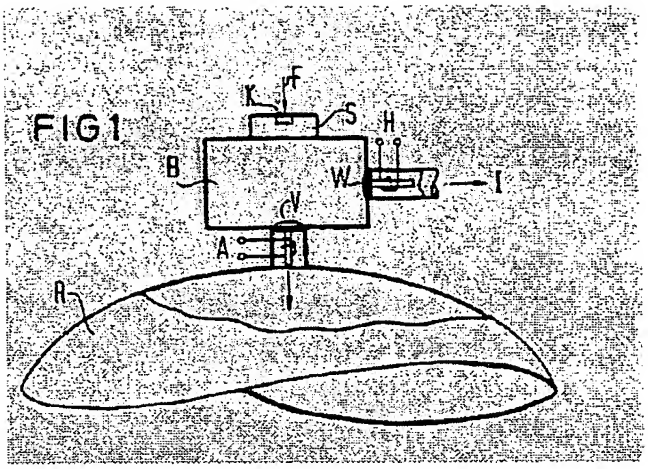
Request for examination in accordance with § 44 of the Patent Code has been made.

(54) **Control System for an Air Bag of a Vehicle**

(57) Control system for one or more air bags (R) of a vehicle, containing an electronic control unit (C, D, E, G), which (C, D, E, G) can inflate the air bag (R) in question with varying intensity, e.g., in stages, in case of a crash, in which [air bag] the amount of gas expanding into the air bag (R) during a crash influences the control unit (C, D, E, G). The gas, which is under pressure, is located in a tank (B) at the latest after the inflation is triggered (F). One or more first openings (V), through which (V) the gas shall flow from the tank (B) into the air bag (R) during the crash, are arranged on the tank (B). One or more first valves (V/A), each of which (V) can be controlled by means of the control unit (C, D, E, G) during a crash between the CLOSED and OPEN states, are arranged at the first openings (V).

FIG 1



## Specification

The starting point of the present invention is the subject defined in the preamble of patent claim 1, which has previously become known per se, cf., e.g., DE-A-24 50 235, which contain [sic, contains? - Tr.Ed.] thus, e.g., a plurality of firable gas generators per se in order to be able to inflate the air bag with varying intensity.

The present invention thus pertains to the optimization of the control of the filling of an air bag, whose filling shall namely be with varying intensity depending on the severity of the crash, so that the passenger to be protected is restrained, if possible, not too strongly, but also not too weakly depending on the severity of the crash.

In addition, a longer series of documents, which pertain to similar control systems for an air bag of a vehicle, which contain a control electronics, but do not contain such an electronic control unit inflating the air bag with varying intensity, are known per se. However, they still additionally contain a tank, in which is located a gas under pressure at the latest as soon as the crash sensor indicated the crash and a control electronics triggered the inflation of the air bag, whereby one or more openings, through which the gas shall flow from the tank into the air bag during the crash, are arranged at the tank, cf., e.g.,
- US 38 77 720,
- US 40 04 827,
- US 40 21 058,
- US 40 43 572,
- DE-A-19 42 154,
- DE-A-19 53 666, and
- DE-A-19 55 145, especially p. 19, last paragraph.

The present invention was first developed for the air bag system of a motor vehicle. It has been shown, however, that it can also be applied to other systems falling under the above-stated preamble. The present invention is especially also suitable, e.g., for air bag systems of trucks, but particularly also for air bag systems of very fast vehicles, e.g., of aircraft, because very particularly different impact speeds and very different optimal duration for the maintenance of the inflated state of the air bag may occur there during a crash.

The object of offering a new way to optimize the control of the inflation of air bags with varying intensity is accomplished according to the present invention by the subject defined in patent claim 1.

The subjects defined in the subclaims make it possible to achieve additional advantages. Among others, namely, the additional measures make it possible according to patent claim

2, to be able to lower the pressure very quickly in the tank to lower, better optimized values;

3, to be able to consider the very different change between weak and strong deceleration phases in a crash, and especially to be able to inflate the air bag with simple means in a manner very adapted to the respective - very different from crash to crash - course of the decelerations, i.e., to be able to readily meter with high flexibility the filling of the air bag in an especially simple manner, i.e., one especially requiring few first valves, depending on the severity of the crash and depending on the course of the decelerations, - instead of achieving this only very approximately, e.g., by providing a plurality of first valves that can only be controlled fully CLOSED and fully OPEN, some of which

or all valves are controlled, depending on the severity of the crash, in that state, in which they are fully OPEN for a single, unchanged, predetermined duration - or perhaps also, as it were, an endless duration;

4, to be able to achieve an especially fine metering of the respective filling of the air bag depending on the respective time course of the decelerations;

5, to achieve an especially good, i.e., especially well optimized, inflation of the air bag, adapted to the crash conditions present in each case;

6, to be able to achieve a filling of the air bag depending on the course of the crash with especially little effort;

7, to be able to achieve an especially fine filling of the air bag adapted to the course of the crash with especially little effort; as well as

8, to be able to achieve a fine filling of the air bag adapted to the course of the crash with very particularly little effort.

The present invention and variants of the same are further explained based on the exemplary embodiments of the present invention shown in the two figures, each of which was shown as simply as possible for the sake of clarity. **Figure 1** schematically shows an example of the design of the present invention, whereby the control electronics is not shown, however, for the sake of clarity, and Figure 2 schematically shows an example of the design of the control unit, which controls the example shown in Figure 1.

Thus, both figures show examples of a control system according to the present invention for the air bag R of a vehicle, shown here in a highly schematic manner. The gas under pressure, which finally inflates the air bag R, or inflates a plurality of air bags R, is located in the tank B constantly or at least at the latest - e.g., after the firing of the primer K of a gas generator S indicated in Figure 1 - after the triggering of the inflation. Namely, one or more first openings, cf. V in both figures, through which the gas shall flow from the tank B into the air bag R or into the air bags R during the crash, are arranged at the tank B. According to the present invention, one or more first valves V/A, each of which can be controlled by means of the control unit during a crash between the CLOSED and OPEN states, are arranged at these first openings V for this purpose. By the way, for the sake of simplicity, in terms of linguistics below, it is assumed that only one air bag R is present, and the reader will not have serious difficulties also referring all data to control systems, in which several air bags are filled via the tank B via own first valves V/A, possibly with slightly deviating times and with deviating gas pressure.

**Figure 2** shows an example of the electronic control unit C, D, E, G, which can inflate the air bag R during a crash with varying intensity, e.g., in stages or even continuously, as this control unit C, D, E, G influences the amount of gas expanding in the air bag R during a crash.

In the example shown, the tank B is not constantly under pressure, but rather is placed under pressure as needed. To this end, the circuit E, in the example shown, recognizes at the right time - e.g., from the course of the initial signal of the crash sensor C and/or from the interim results of the circuit D - when the primer K of the gas generator S is to be fired by means of an intermediate amplifier F, so that the necessary gas pressure is available in the tank B at the right time.

Thus, in the example shown in **Figure 2**, the unit C thus forms a crash sensor - or possibly a system of a plurality of crash sensors, whereby each of these crash sensors is, e.g., a semiconductor sensor or a piezoelectric crash sensor, and therefore supplies, e.g., analogous initial signals which correspond to the deceleration or acceleration, i.e., negative deceleration, at the current moment - whereby the unit C can supply these initial signals in a digitized pattern, as needed, also by means of an A/D converter provided in C.

The circuit D analyzes the current deceleration measured by the unit C as this circuit D, e.g., integrates and/or differentiates these decelerations and compares them to different threshold values, whereby these different threshold values are each assigned to different crash situations - e.g., head-on collision, diagonal collision, side collision, possibly also rear collision with or without resulting head-on or diagonal collision, - and possibly also each with or without rotation of the vehicle about its main axes. Thus, the circuit D diagnoses the manner, the current phase and the overall severity of the crash.

Finally, the circuit G controls the first valve V/A in its OPEN state corresponding to the current phase of the crash, cf. also Figure 1, via the valve drive A, which is electromechanical here. This is preferably a first valve, which can be controlled both in its OPEN state and, if necessary, again in its CLOSED state extremely quickly and thus with proper metering via its valve drive A.

Thus, the present invention offers a novel way to achieve as optimal as possible protection of passengers depending on the manner and the severity of the crash. The present invention makes it possible, particularly, to optimize both the duration and the intensity of the inflation of air bags by means of controlling the first valve V/A or first valves V/A, if necessary, above all as the openings V can be opened, metered as needed, with the first valve V/A or as a plurality of first openings V can be opened with first valves V/A. The circuit D or the control unit C/D/E/F/G in conjunction with the first valve V/A or in conjunction with the first valves V/A thus offer a novel way to inflate the air bag for a sufficient length of time with an amount of gas adapted to the severity of the crash, above all also adapted to the current phase of the crash, such that the passenger to be protected is restrained, if possible, not too strongly, but also not too weakly, depending on the severity of the crash, and moreover, also long enough, - as some of the values of the decelerations may fluctuate during the crash as well.

The example shown contains nothing but distinct circuits or units C/D/E/F/G for the control unit. All or at least some of these circuits or units may, however, also be assembled into a common unit, e.g., may also be formed by a single, correspondingly memory-programmed microcomputer, which may additionally possibly contain still one or more semiconductor sensors C integrated on the chip.

The pressure in the tank B can be lowered especially quickly, as needed, to lower, even more optimized values - e.g., in order not to have to control the first valve V/A or the first valves V/A too quickly between its CLOSE states and OPEN states, if at least one second valve W/H is additionally arranged at one or more second openings W of the tank B, whereby the gas shall flow somewhere away from the tank B, e.g., into the open I or into the engine space I, but not into the air bag R by means of these additional openings W of the tank B during the crash, and if each second valve W/H can be controlled between its CLOSED and OPEN states by means of the control unit C, D, E, G, likewise during a crash, adapted to the respective severity of the crash phase.

One may often already content oneself with achieving only a very approximate adaptation of the intensity and duration of the filling of the air bag in a manner according to the present invention,

by providing a plurality of first valves V/A, which can be controlled only fully CLOSED and fully OPEN, some of which, depending on the severity of the current phase of the crash, or all first valves V/A can be controlled in their OPEN state, whereby these first valves V/A are fully controlled in their OPEN state, e.g., - in order to minimize the technical effort - each for a single, unchanged, predetermined duration - or perhaps also, as it were, for an endless duration. This brings about a control of the air bag in more or less approximate stages.

However, instead of this, the very different change between weak and strong deceleration phases in a crash can be taken into much closer consideration, and it is possible to inflate the air bag with simple means, very adapted to the respective - very different from crash to crash - course of the decelerations, i.e., the filling of the air bag can be readily metered, with high flexibility, in a manner that is especially simple and particularly requiring few first valves, depending on the severity of the crash and depending on the course of the decelerations. To this end, the control unit, cf. C, D, E, F, G, may namely also be dimensioned such that it controls the opening V or W in question during a crash with the associated first and/or second valve V/A, W/H in an OPEN state to varying intensity and/or controls for different lengths of time in its OPEN state.

An especially fine metering of the respective filling of the air bag can be achieved, depending on the respective time course of the decelerations, if the control unit C, D, E, F, G, in a crash, controls the opening V and/or W in question with the associated first and/or second valve V/A, W/H each in a more or less continuous manner in the OPEN state to varying intensities and/or controls in a more or less continuous manner for various lengths of time in the OPEN state. Above all, the duration of the OPEN state, which can be varied continuously, can be achieved with simple means. It is hereby assumed that a digital, but extremely finely staggered, operating control unit C/D/E/F/G can be designated as a continuously operating control unit.

A control of the valve or valves especially well adapted to the crash conditions present in each case can be achieved, i.e., an especially well optimized inflation of the air bag can be achieved if a pressure sensor, e.g., an especially quickly measuring piezoelectric pressure sensor - not shown in the figures for the sake of clarity - is arranged in or at the air bag R, so that this pressure sensor determines the gas pressure prevailing in the interior of the air bag during the inflation of the air bag R. The pressure sensor then sends its initial signal to the control unit C, D, E, F, G, as a result of which this control unit, which is especially well adapted to the severity of the current crash phase, can control the first valve V/A or the first valves V/A, possibly also the second valve W/H or the second valves W/H, such that the gas pressure in the air bag interior corresponds as accurately as possible to an ideal DESIRED value; this DESIRED value, which is assigned to the respective crash phase, may be, e.g., also stored as an ideal DESIRED value for such a special crash course in a PROM memory of the control unit, whereby this memory may be arranged, e.g., in the circuit G.

A filling of the air bag depending on the course of the crash can be achieved with especially little effort if the control unit C, D, E, F, G, in the initial phase of the crash, first inflates the air bag R with a first amount of gas for the triggering of the air bag R - by means of controlling one or more first valves V/A, and if this control unit C, D, E, F, G, in a later phase or several later phases of the crash, inflates the air bag R with another amount of gas or several other amounts of gas one after the other - again by means of corresponding control of one or more first valves V/A.

A filling of the air bag that is especially finely adapted to the course of the crash can then be achieved with especially little effort if the control unit C, D, E, G inflates, in one or more phases of the crash, the air bag R - again by means of corresponding control of the first and/or second valve V/A, W/H, and/or by means of control of the first and/or second valves V/A, W/H - each with a

different amount of additional gas, namely each with an amount of gas adapted to the most recently determined deceleration values. As a result, the control unit C, D, E, F, G can adapt the ratio of the additional, later amount of gas to the first amount of gas, depending on the severity and/or duration of the later phase in question, to the current, different need in each case.

A filling of the air bag, finely adapted to the course of the crash, can be achieved with very particularly little effort if only a single, and especially only the first valve V/A, is arranged at the tank B, and if additionally the control unit C, D, E, F, G, in the initial phase of the crash - inflates the air bag R first with a first amount of gas - again by means of corresponding control of this valve V/A -, and if this control unit C, D, E, G, in at least one of the later phases of the crash, inflates the air bag R at least once - again by means of corresponding control of the valve V/A - with another amount of gas - and as specifically as possible, i.e., adapted to the currently measured deceleration values.

## Patent Claims

1. Control system for a said air bag (R) of a vehicle,
with a said electronic control unit (C, D, E, G), which (C, D, E, G) can inflate the said air bag (R) with varying intensity, e.g., in stages, in case of a crash, as the said control unit (C, D, E, G) influences the amount of gas expanding in the said air bag (R) during a crash,
**characterized in that**
- a said tank (B) is provided, in which (B) is located the gas under pressure at the latest after the inflation has been triggered (F),
- that one or more said first openings (V), through which (V) the gas shall flow from the said tank (B) into the said air bag (R) during the crash, are arranged at the said tank (B), and
- that one or more said first valves (V/A), each of which (V) can be controlled by means of the said control unit (C, D, E, G) during a crash between the CLOSED and OPEN states, are arranged at the said first openings (V).

2. Control system in accordance with patent claim 1, characterized in that
- at least one said second valve (W/H), through which (W) the gas shall flow away (I) from the said tank (B), but not into the air bag (R), is arranged at one or more said second openings (W) of the tank (B), and
- that each said second valve (W/H) can be controlled by means of the said control unit (C, D, E, G) during a crash between the CLOSED and OPEN states.

3. Control system in accordance with patent claim 1 or 2, characterized in that
- the said control unit (C, D, E, G) can control the said opening (V, W) in question during a crash with the associated said first and/or second valve (V/A, W/H) in a state that is OPEN to varying intensity and/or in the OPEN state for varying lengths of time.

4. Control system in accordance with claim 3, characterized in that
- the said control unit (C, D, E, G) can control the said opening (V, W) in question during a crash with each of the associated said first and/or second valves (V/A, W/H) in a state that is OPEN to varying intensity and/or in a more or less continuous manner for varying lengths of time in the OPEN state.

5. Control system in accordance with one of the above claims, characterized in that
- a pressure sensor is arranged in or at the air bag (R) proper, and
- that the pressure sensor determines the gas pressure prevailing in the interior of the said air bag (R) during the inflation of the said air bag (R) and sends its pressure sensor initial signal to the said control unit (C, D, E, G).

6. Method for operating the control system in accordance with one of the above patent claims in a crash of such intensity that an inflation of the said air bag (R) is triggered, characterized in that
- the said control unit (C, D, E, G), in the initial phase of the crash, inflates the said air bag (R) with a first amount of gas by means of controlling one or more said first valves (V/A), and
- that the said control unit (C, D, E, G), in a later phase or in a plurality of later phases of the crash, inflates the said air bag (R) with another amount of gas or several other amounts of gas one after the other by means of controlling one or more said first valves (V/A).

7. Method in accordance with patent claim 6, characterized in that

- the said control unit (C, D, E, G), in one or more phases of the crash, inflates the said air bag (R) by means of controlling the said first and/or second valve (V/A, W/H) and/or by means of controlling the said first and/or second valves (V/A, W/H) each with a different amount of additional gas, namely with an amount of gas respectively adapted to the most recently determined deceleration values, so that the said control unit (C, D, E, G), by means of this controlling, makes the ratio of the additional amount of gas to the first amount of gas vary from case to case, namely depending on the severity and/or the duration of the later phase in question.

8. Method in accordance with patent claim 6 or 7 with only one, in particular with only the said first valve (V/A), characterized in that

- the said control unit (C, D, E, G), in the initial phase of the crash, inflates the said air bag (R) with a first amount of gas by means of controlling the said valve (V/A), and
- that the said control unit (C, D, E, G), in at least one of the later phases of the crash, inflates the said air bag (R) at least once with an additional amount of gas by means of controlling the said valve (V/A).

1 page(s) of drawings attached

DRAWINGS, PAGE 1

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FIG 1

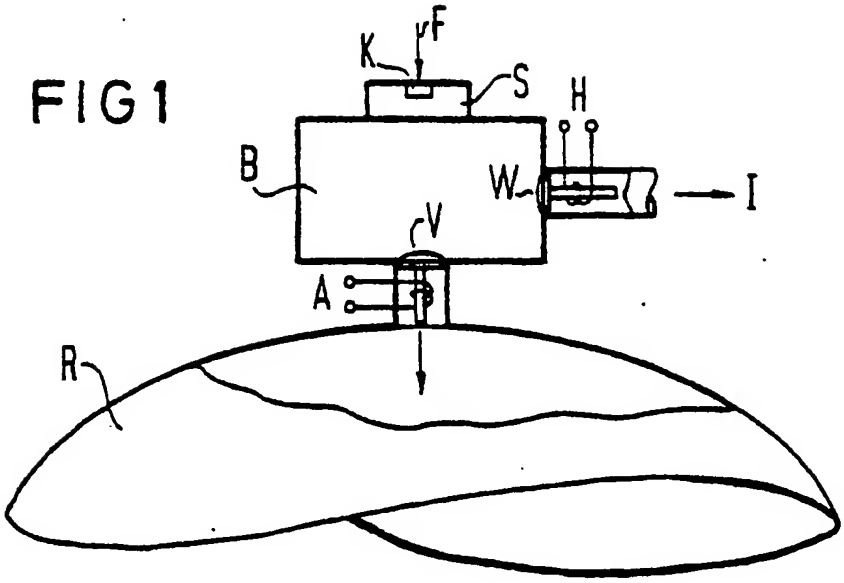


FIG 2